Title

Association of motivations and barriers with participation and performance in a pedometer-based intervention

Journal

Nephrology Dialysis Transplantation, 35(8)

ISSN

0931-0509

Authors

Sheshadri, Anoop
Kittiskulnam, Piyawan
Delgado, Cynthia
et al.

Publication Date

2020-08-01

DOI

10.1093/ndt/gfaa047

Peer reviewed

28. Bjornstad P, Wiromrat P, Johnson RJ *et al.* Serum uromodulin predicts less coronary artery calcification and diabetic kidney disease over 12 years in adults with type 1 diabetes: the CACTI study. *Diabetes Care* 2019; 42: 297–302
29. Pivin E, Ponte B, de Seigneux S *et al.* Uromodulin and nephron mass. *Clin J Am Soc Nephrol* 2018; 13: 1556–1557
30. Coppo R, Troyanov S, Bellur S *et al.* Validation of the Oxford classification of IgA nephropathy in cohorts with different presentations and treatments. *Kidney Int* 2014; 86: 828–836
31. Matsushita K, van der Velde M, Astor BC *et al.* Association of estimated glomerular filtration rate and albuminuria with all-cause and cardiovascular mortality in general population cohorts: a collaborative meta-analysis. *Lancet* 2010; 375: 2073–2081
32. McCullough PA, Beaver TM, Bennett-Guerrero E *et al.* Acute and chronic cardiovascular effects of hyperkalemia: new insights into prevention and clinical management. *Rev Cardiovasc Med* 2014; 15: 11–23
33. Hagstrom E, Ahlstrom T, Arnlov J *et al.* Parathyroid hormone and calcium are independently associated with subclinical vascular disease in a community-based cohort. *Atherosclerosis* 2015; 238: 420–426
34. Sejdiu I, Torffvit O. Decreased urinary concentration of Tamm–Horsfall protein is associated with development of renal failure and cardiovascular death within 20 years in type 1 but not in type 2 diabetic patients. *Scand J Urol Nephrol* 2008; 42: 168–174
35. Scolari F, Izzi C, Ghiggeri GM. Uromodulin: from monogenic to multifactorial diseases. *Nephrol Dial Transplant* 2015; 30: 1250–1256
36. Liu Y, Goldfarb D, El-Achkar TM *et al.* Tamm–Horsfall protein/uromodulin deficiency elicits tubular compensatory responses leading to hypertension and hyperuricemia. *Am J Physiol Renal Physiol* 2018; 314: F1062-F1076
37. Borghi C, Rossi F. Role of the renin–angiotensin–aldosterone system and its pharmacological inhibitors in cardiovascular diseases: complex and critical issues. *High Blood Press Cardiovasc Prev* 2015; 22: 429–444
38. Grassi D, Desideri G, Di Giacomantonio AV *et al.* Hyperuricemia and cardiovascular risk. *High Blood Press Cardiovasc Prev* 2014; 21: 235–242
39. Joseph JJ, Echouffo-Tcheugui JB, Kalyani RR *et al.* Aldosterone, renin, cardiovascular events, and all-cause mortality among African Americans: the Jackson Heart Study. *JACC Heart Fail* 2017; 5: 642–651
40. Trudu M, Janas S, Lanzani C *et al.* Common noncoding UMOD gene variants induce salt-sensitive hypertension and kidney damage by increasing uromodulin expression. *Nat Med* 2013; 19: 1655–1660

Received: 7.8.2018; Editorial decision: 9.1.2019

Nephrol Dial Transplant (2020) 35: 1405–1411
doi: 10.1093/ndt/gfaa047
Advance Access publication 21 May 2020

Association of motivations and barriers with participation and performance in a pedometer-based intervention

Anoop Sheshadri[1,2], Piyawan Kittiskulnam[3,4], Cynthia Delgado[1,2], Rebecca Sudore[2,5], Jennifer C. Lai[6] and Kirsten L. Johansen[7,8]

[1]Department of Medicine, Division of Nephrology, University of California, San Francisco, CA, USA, [2]Department of Medicine, Division of Nephrology, San Francisco Veterans Affairs Medical Center, San Francisco, CA, USA, [3]Department of Medicine-Division of Nephrology, Chulalongkorn University, Bangkok, Thailand, [4]Special Task Force for Activating Research in Renal Nutrition (Renal Nutrition Research Group), Office of Research Affairs, Chulalongkorn University, Bangkok, Thailand, [5]Department of Medicine, Division of Geriatrics, University of California, San Francisco, CA, USA, [6]Department of Medicine, Division of Gastroenterology/Hepatology, University of California, San Francisco, CA, USA, [7]Division of Nephrology, Hennepin County Medical Center, Minneapolis, MN, USA and [8]Division of Nephrology, University of Minnesota, Minneapolis, MN, USA

Correspondence to: Anoop Sheshadri; E-mail: Anoop.Sheshadri@ucsf.edu; Twitter handles: @Delgadockdny, @AnoopSheshadri

ABSTRACT

Background. A randomized trial of a pedometer-based intervention with weekly activity goals led to increased walking among dialysis patients. However, the association of participant-expressed motivations and barriers to participation and performance in such an intervention has not been determined.

Methods. Thirty dialysis patients were randomized to a 12-week pedometer-based intervention with weekly step goals. Participants were asked about motivations and barriers to the increasing activity via weekly semi-scripted telephone interviews. We examined the association of these motivations and barriers with achieving weekly goals, reaching overall targets and increasing steps through multivariable linear and logistic regression analyses adjusted for age, sex, body mass index, dialysis modality and baseline steps.

Results. The most common motivations were desire to maintain/improve functional ability (30%) and activity (30%). The most common barriers were health-related (33%). Motivation to maintain/improve functional ability was associated with achieving weekly goals 17.9% more often [95% confidence interval (CI) 1.7–34.2] and with a greater increase in steps (1524 steps; 95% CI 61–2989) than those lacking this motivation. Experiencing a health-related barrier was not associated with

the decreased achievement of weekly goals but was associated with lower odds of reaching overall targets (odds ratio = 0.06; 95% CI 0.01–0.53) and a smaller increase in steps (−1640 steps, 95% CI −3244 to −36). No patients who reported weather/environmental barriers or safety concerns reached overall targets.

Conclusions. Participants who express a desire to maintain/improve functional ability may be particularly suited for activity interventions. Health-related setbacks should be met with revised goals. Reporting environmental or safety concerns may merit lowering overall targets.

Keywords: barriers, dialysis, exercise, motivations, physical activity

ADDITIONAL CONTENT

An author video to accompany this article is available at: https://academic.oup.com/ndt/pages/author_videos.

INTRODUCTION

Patients treated with dialysis report very low levels of physical activity [1–3], and this sedentary behavior is associated with functional impairment [4, 5] and higher mortality [6, 7]. Furthermore, most of the physical activity reported by dialysis patients is of low intensity [8], with walking being the primary form of physical activity [9]. Moderate or vigorous exercise and physical activity interventions are known to improve physical function and quality of life outcomes in dialysis patients [7, 10–12]. However, only a small percentage of patients have been willing and able to participate in such interventions [13], and it is possible that low-intensity activity is sufficient to provide benefit in this patient population [14].

Dialysis patients have previously reported positive motivation to exercise or increase activity, including a desire to improve energy, maintain independence, improve longevity and qualify to be waitlisted for kidney transplantation [15]. However, in studies exploring barriers to exercise in the dialysis population, patients have reported fatigue and shortness of breath as substantial challenges [15, 16]. Given patients' concerns about fatigue, shortness of breath and cramping [17, 18], a low-intensity intervention may be more feasible for dialysis patients, particularly a home-based, flexible intervention rather than a scheduled in-center rehabilitation program [19]. However, patients have not been questioned about motivators or barriers to such a low-intensity intervention.

To examine the feasibility and tolerability of a low-intensity walking program, we collected data on participant-expressed motivators and barriers to walking during a randomized controlled trial comparing pedometers and weekly step goals to usual care among 60 patients treated with dialysis for 12 weeks [Pedometers and Exercise in Dialysis (PED)]. The aim of this study was to describe perceived barriers and motivators and to examine the associations between participant-expressed motivations and barriers and achievement of weekly step goals, the achievement of overall step targets for the duration of the study and change in step count during the 12-week intervention.

MATERIALS AND METHODS

Inclusion and exclusion criteria

We enrolled 60 patients from three San Francisco dialysis clinics into the PED study [20]. This analysis includes the 30 participants who were randomly assigned to the intervention. Inclusion criteria for the PED study were age ≥18 years, receiving in-center hemodialysis (HD) or any form of peritoneal dialysis (PD), being ambulatory by clinician assessment and having telephone access. Patients using a cane or other assistive device were eligible, but those using wheelchairs or scooters were excluded. Patients provided written informed consent to participate. The PED study adheres to the Declaration of Helsinki, was approved by the University of California, San Francisco (UCSF) Committee on Human Research and was registered at ClinicalTrials.gov (NCT02623348).

Baseline testing and step count measurement

Participants were asked their race, ethnicity, age and sex. We reviewed medical records for laboratory results, comorbidities, medications and dialysis prescriptions. Step counts were measured using pedometers (Accusplit AE120, Livermore, CA, USA) [21–24]. Patients were asked to wear the pedometer on their belt or waistband continuously during waking hours for 1 week prior to baseline assessment and to record their daily steps in a step diary and then re-set the pedometer each morning. Baseline step counts were relayed to study personnel in person at a regular dialysis session or via telephone.

Randomization and intervention

Patients were randomly assigned to participate in a 12-week intervention program or control group in a 1:1 ratio, stratified by dialysis modality. Full details of recruitment and enrollment have been previously described [20]. The intervention consisted of providing pedometers in conjunction with semi-scripted counseling sessions in which a member of the study team called the participant at a scheduled time each week for 12 weeks. Participants in the intervention were asked to wear their pedometers and to record their step counts in a daily log for 12 weeks. During the weekly counseling session, participants reported their steps and research personnel provided specific goals for daily walking in the upcoming week and advised about ways to incorporate more walking into participants' daily routines (Supplementary data).

We recommended that participants increase their steps by 10% each week compared with the prior week. At the start of the intervention, participants were given a graphical projection of the expected trajectory of their average daily step counts over the 12-week intervention if they were able to successfully increase their steps by 10% each week. Their projected step count at 12 weeks was considered their overall target, to a maximum of 10 000 steps/day. If patients did not meet their weekly target, then we did not set a higher target for the subsequent week. In addition, for patients who had periods of reduced walking (e.g. after hospitalizations or other events), we revised their goals (i.e. increasing in 10% increments of their new 'baseline' daily steps). Participants were given feedback about their revised projections going out to the end of the intervention if they were

able to successfully increase steps by 10% each week from their new baseline but were not formally given a new overall target. We measured step counts over 1 week after 12 weeks to evaluate the effect of the intervention.

Weekly counseling session

Participants in the intervention group were asked about any personal motivations for increasing activity prior to randomization and again at each weekly counseling session ('Do you have any personal goals that you want to accomplish by increasing your activity level?') through semi-scripted qualitative interviews (Supplementary data). Participants were also asked about any barriers to increasing activity that they anticipated prior to beginning the intervention and any barriers that they experienced during the preceding week at each weekly counseling session ('Barriers, if any, in reaching your goal?'). Responses to these telephone interview questions were documented by study staff, with accompanying quotes using the participants' own words. Counseling sessions lasted ∼10–15 min. At the end of each session, participants and study personnel discussed ways in which patients might overcome expressed barriers (e.g. walking indoors if a patient reported rain as a barrier).

Statistical analysis

Patients' baseline characteristics were summarized as median (25–75th percentile) for continuous variables or frequency and percentage for categorical variables. For step counts, we calculated the average daily steps over the week prior to each assessment for each participant and reported the mean of those average daily step counts.

At the end of the intervention, responses from counseling sessions were coded into themes that were refined through serial review. The analytic approach involved applying a thematic framework [25] that allowed incorporating *a priori* considerations as well as emerging themes from the data. We explored the association of participant-expressed motivations and barriers with the percentage of weeks in which step goals were achieved using multivariable linear regression analysis and whether participant-expressed motivations and barriers were associated with odds of meeting overall target steps using multivariable logistic regression. We also explored the association of participant-expressed motivations and barriers with a change in step count from 0 to 12 weeks using multivariable linear regression analysis. Multivariable analyses adjusted for age, sex, body mass index (BMI), dialysis modality and average daily step count at baseline. Finally, we performed *post hoc* univariable logistic regression analyses to explore associations between baseline characteristics (age, sex, race/ethnicity, BMI, dialysis vintage, dialysis modality, education and smoking status) and particular motivations or barriers. Two-sided $P < 0.05$ were considered statistically significant. Statistical analyses were performed using Stata, version 14 (StataCorp, College Station, TX, USA).

RESULTS

Baseline characteristics, step counts and symptoms

The intervention group consisted of 24 HD and 6 PD patients. The median age of participants was 60 years (53–66) and 93% were men (Table 1). Forty-seven percent were black, 20% Asian and 13% white. Median BMI was 26.9 (25.3–32.9) kg/m^2. The most common comorbidity was hypertension (93%). Thirty percent of participants used an assistive device for walking. The mean of participants' average daily step count at baseline was 3924 (±3422), which increased to 5863 (±4019) at the end of the 12-week intervention period. Baseline characteristics in the intervention group were similar to those of the control group apart from the distribution of sex (37% men in the control group).

Participation and dropout rates

Ninety percent of the patients in the intervention completed the 12-week program, and 83% of all calls were completed as planned. Participants achieved a median of 33% (25–67) of their weekly step goals (i.e. met their weekly target during 4 of the 12 weeks of the intervention), and 37% of participants were able to achieve their overall target at the end of 12 weeks.

Motivations and barriers

Seventy-three percent of participants expressed at least one motivation extrinsic to the step count goals provided by study personnel. The most common motivations expressed were

Table 1. Patient characteristics at baseline for 30 participants

Characteristic	Median (25–75th percentile) or %
Age, years	60 (53–66)
Sex, % male	93
Hispanic, %	17
Race, %	
White	13
Black	47
Asian	20
Other	20
BMI, kg/m^2	26.9 (25.3–32.9)
Comorbidities, %	
HTN	93
DM	33
CAD	37
CHF	30
Stroke	7
Peripheral vascular disease	13
Arrhythmia	20
Dialysis modality, %	
HD	80
PD	20
Dialysis vintage, years	3.7 (1.5–7.2)
Hemoglobin, g/dL	10.6 (9.6–11.7)
Serum albumin, g/dL	3.9 (3.6–4.1)
Std K_t/V	2.30 (2.07–2.44)
Education, %	
High school or less	37
Vocational or some college	33
College degree	13
Professional or graduate degree	20
Currently smoking, %	10
Use of assistive device, %	30
Cane	20
Walker	10

HTN, hypertension; DM, diabetes mellitus; CAD, coronary artery disease; CHF, congestive heart failure.

desire to maintain or improve their functional ability (30%) and desire to maintain or improve their activity level (30%), followed by losing weight to qualify for kidney transplantation (27%) and individual personal motivations [e.g. spending more time with family, training a new dog (20%)] (Table 2).

Table 2. Motivations and barriers expressed by dialysis patients in the PED study

Participant-expressed motivations and barriers	%
Maintain or improve functional ability	30
Maintain or improve activity level	30
Lose weight for kidney transplantation	27
Other personal motivation	20
Any motivation extrinsic to study	73
Number of motivations expressed (25–75th)	1 (0–2)
Lack of motivation	30
Problems with use of pedometer	17
Concern about safety while walking	7
Health-related barrier (e.g. hospitalization, ER visit, and illness)	33
Reported barrier specific to dialysis	27
Post-dialysis fatigue	13
Difficulty with ultrafiltration leading to increased swelling	13
Hypotension during dialysis	3
Reported symptoms that prevented walking to best of ability	27
Dyspnea with exertion	10
General body soreness	10
Foot or leg pain	7
Fatigue	10
Chest pain	7
Weather or other environmental barriers	13
Any barrier to activity intervention	77
Number of barriers expressed (25th–75th)	1 (0–2)

Seventy-seven percent of participants reported at least one barrier to activity. The most common barrier reported prior to the intervention was lack of motivation (30%), followed by initial difficulty using the pedometer (17%) and concerns about safety while walking (7%). The most common barrier reported to study personnel during the intervention was a health-related barrier such as an illness or hospitalization (33%). Dialysis-related barriers to walking were expressed by 27% of participants, including 13% reporting post-dialysis fatigue, 13% inability to remove adequate amounts of fluid during dialysis or bothersome swelling despite dialyzing per prescription, and 3% intradialytic hypotension. Twenty-seven percent of participants also reported extra-dialytic symptoms that affected their ability to walk at their best level, with the most common being dyspnea with exertion, general body soreness and fatigue. Finally, 13% of participants reported that their ability to walk was adversely affected by the weather. Example quotations illustrating these motivations and barriers are included in Table 3.

Association of motivations with outcomes

Participants who were motivated to maintain or improve functional ability achieved their weekly goals 17.9% more often than participants who did not express this motivation [95% confidence interval (CI) 1.7–34.2] after adjusting for age, sex,

Table 3. Example quotations of motivations and barriers reported by participants in the PED study

Motivations and barriers	
Participant-expressed motivations and barriers	
Maintain or improve functional ability	'I just want to be able to do the things I used to do. Stand up straight and tall. Go on hikes with my family. We used to hike all around Marin'.
	'I've got this walker, so I guess I should be using it to walk. If I do that enough, maybe I won't have to use it anymore'.
Maintain or improve activity level	'I used to be a lot more active before dialysis. I want to get back to where I was before all this'.
Lose weight for kidney transplantation	'I have this goal of losing one and a half kilos each month so I can get back on the list'.
Other personal motivation	'I'm going to get a new service dog, and this'll be a good time to train him'.
Lack of motivation	'I just spent Monday and Tuesday pretty much in bed. Not sure why'.
	'I saw that goal, and I didn't think I could reach it, so I didn't think it was worth trying'.
Problems with utilizing pedometer initially	'I wear sweatpants to dialysis, and I've got no belt loop. When you clip it on, it sags, and then it doesn't give you the right number'.
	'It didn't seem like it was working so I didn't put it on'.
Concern about safety while walking	'I've been told I need to be more careful when I'm moving around'.
	'My wife tells me she's afraid I might fall, so she doesn't like me to go outside. I've had falls before'.
Health-related barrier	'I had to go to the ER, with chest pain again. So that week was a bust'.
	'It's time for my colonoscopy and I couldn't really go anywhere for a while'.
	'I was getting cataract surgery, so I figured I'd wait'.
Reported symptoms that prevented walking to best of ability	'I have chest pain when I walk sometimes, and I have to stop. I don't want to do more than my body can do – I know my body'.
	'I just kept having coughing fits. It was hard to breathe, and I didn't like that'.
	'I'm wearing a leg brace, but I've still got this knee pain'.
Reported barrier specific to dialysis	'I'm just too tired after dialysis. It takes me about a day to recover'.
	'How I feel, it really depends on my blood pressure. If it gets too low – say, lower than 120 – I get lightheaded. Things start to move, and I have to get steady'.
	'I've just got too much fluid on me'.
Weather or other environmental issues	'There's not a lot of places to walk around here, and some of the people, I don't always feel comfortable walking'.
	'It's just been raining all week, and the pavement here is uneven. My wife is worried I might slip and fall. I got this cane, but you know how it is'.

Table 4. Association of motivations or barriers with a percentage of weekly goals met, likelihood of achieving target steps and change in step counts from 0 to 12 weeks in 24 HD and 6 PD patients

	Percentage of weekly goals achieved (linear regression)		Likelihood of achieving target steps (logistic regression)		Change in steps from 0 to 12 weeks (linear regression)	
	Adjusted[a] (95% CI)	P-value	OR, adjusted[a] (95% CI)	P-value	Adjusted[a] (95% CI)	P-value
Participant-expressed motivations and barriers						
Maintain or improve functional ability	17.9% (1.7 to 34.2)	0.03	2.03 (0.51 to 8.05)	0.31	1524 (61 to 2989)	0.04
Maintain or improve activity level	12.3% (−2.7 to 27.3)	0.11	1.59 (0.39 to 6.48)	0.52	−631 (−2145 to 882)	0.41
Lose weight for kidney transplantation	1.8% (−16.8 to 20.3)	0.85	0.93 (0.21 to 4.04)	0.92	−661 (−2417 to 1096)	0.46
Other personal motivation	−3.7% (−20.0 to 12.6)	0.65	0.81 (0.18 to 3.48)	0.77	1174 (−318 to 2667)	0.12
Lack of motivation	−8.9% (−24.7 to 6.9)	0.26	0.73 (0.16 to 3.25)	0.68	−793 (−2347 to 762)	0.31
Problems with utilizing pedometer initially	−8.4% (−26.1 to 9.2)	0.34	3.88 (0.72 to 20.98)	0.12	605 (−970 to 2181)	0.45
Concern about safety while walking	7.2% (−26.5 to 27.9)	0.96	0	[b]	−933 (−2441 to 574)	0.22
Health related barrier (e.g. hospitalization, ER visit, illness)	−11.8% (−26.4 to 2.7)	0.11	0.06 (0.01 to 0.53)	0.01	−1375 (−2705 to −44)	0.04
Reported symptoms that prevented walking to best of ability (per symptom reported)	−3.9% (−10.6 to 2.8)	0.25	0.70 (0.35 to 1.43)	0.33	−322 (−917 to 272)	0.28
Reported barrier specific to dialysis (per issue reported)	3.1% (−11.4 to 17.5)	0.67	0.83 (0.21 to 3.31)	0.80	86 (−1262 to 1434)	0.90
Weather or other environmental issue	−15.6% (−34.3 to 3.2)	0.1	0	[b]	−1640 (−3244 to −36)	0.05

[a]Adjusted for age, sex, BMI, modality and baseline average step count.
[b]Insufficient heterogeneity for analysis.

BMI and baseline step count (Table 4). No other individual motivation was associated with achieving weekly goals in multivariable analysis. There was no association between reporting any participant-expressed motivation and odds of meeting overall step targets.

Participants who were motivated to maintain or improve functional ability were able to increase their steps during the intervention period by 1524 more steps (95% CI 61–2989) than participants who did not express this motivation.

Association of barriers with outcomes

No individual barrier was associated with achieving weekly goals. Experiencing a health-related barrier was associated with lower odds of achieving the overall step target [odds ratio (OR) = 0.06; 95% CI 0.01–0.53] and was also associated with a smaller increase in step counts (−1640; 95% CI −3244 to −36) from 0 to 12 weeks. No patient who reported weather-related barriers or who reported safety as a concern for walking was able to reach their overall targets.

Post hoc association of baseline characteristics with motivations and barriers

Older age (OR = 0.51/10 years; 95% CI 0.33–0.79, P = 0.01) was associated with lower odds of wanting to lose weight for transplantation and higher BMI with higher odds of motivation to lose weight (OR = 1.21/kg/m^2; 95% CI 1.10–1.34, P < 0.01).

Older participants also had higher odds of having a motivational barrier (OR = 2.36/10 years; 95% CI 1.23–4.54, P = 0.01), whereas higher education level was associated with lower odds (OR = 0.38 per additional level of education; 95% CI 0.16–0.87, P = 0.02). Older age (OR = 1.81/10 years; 95% CI 1.13–2.90, P = 0.01) and higher BMI (OR = 1.13/kg/m^2; 95% CI 1.02–1.25, P = 0.02) were both associated with higher odds of having a dialysis-related barrier. Higher BMI was also associated with higher odds of having a symptoms-related barrier (OR = 1.25/kg/m^2; 95% CI 1.10–1.41, P < 0.01).

Sex, race, dialysis modality and smoking status were not associated with any specific motivators or barriers to increasing walking.

DISCUSSION

The most common participant-expressed motivations for increasing walking were desire to maintain or improve functional ability and desire to maintain activity level. The most common participant-expressed barrier prior to the intervention was lack of motivation, and the most common barrier that arose during the intervention was experiencing a health-related event. Older participants were less likely to have the motivation to increase walking and a higher likelihood of dialysis-related barriers. More educated patients were less likely to have motivational barriers. Higher BMI was associated with a higher likelihood of motivation to lose weight for transplant but also associated with a higher likelihood of dialysis- or symptoms-related barriers to increasing walking. Almost all participants were able to complete the 12-week intervention, and the majority of calls were completed as scheduled. The median attainment of weekly goals was 33% and 37% of participants were able to achieve their overall targets. Desire to maintain or improve functional ability was associated with metrics of success in the program. However, the presence of safety concerns, environmental or weather-related barriers or health-related barriers was associated with worse performance in the intervention.

Previous studies have examined motivators and barriers to exercise in the dialysis population, including one study that found that lack of motivation was associated with lower levels of physical activity, including low-intensity activity such as walking [16]. However, most of these have been single questionnaires asking about potential exercise participation rather

than ongoing evaluations tied to an intervention [15, 16, 19, 26]. Our examination of participant-expressed motivations and barriers experienced during a walking-based intervention is novel, and participants were given the opportunity to report motivators and barriers they experienced in 'real time'. It is interesting, therefore, that participants in our intervention expressed similar motivations and barriers as those reported in other studies in which dialysis patients were asked about theoretical barriers to exercise [15, 16].

Although we do not wish to diminish the importance of addressing barriers to exercise and activity, learning and cultivating motivators of exercise appears to also be important to behavior change. Motivation is known to be a strong facilitator of self-directed exercise [19, 26–28], and qualitative research from patients with chronic kidney disease suggests that for interventions to be successful, interactions with patients should focus on patient autonomy and self-efficacy [28]. In our study, participants who reported a desire to maintain or improve functional ability had the better achievement of weekly goals and greater increases in step counts than participants who did not express this motivation, although this motivation did not translate to a higher likelihood of meeting overall step targets. Nevertheless, increasing steps may have still been beneficial for these participants even without meeting the overall target, given that there is no clear minimum clinically important difference for step counts for dialysis patients and lower levels of activity are associated with higher mortality even below recommended levels [29].

Learning patient-expressed motivations and barriers may be especially important for clinicians seeking to improve activity in their dialysis patients, and patients who receive on-going activity counseling may respond particularly well when engaged with a focus on self-efficacy. However, though patients in the intervention group increased their steps at 12 weeks relative to controls, this increase was not sustained after the active intervention [20]. Actively addressing motivators and barriers to activity may help during the maintenance phase of a potential future activity intervention as well as during the initial titration.

Although the lack of motivation was the most common participant-expressed barrier prior to our intervention, it was not associated with meeting weekly goals or overall targets after adjusting for other factors potentially associated with physical activity. It is possible that study personnel were able to successfully motivate participants to complete their goals through the counseling sessions, overcoming the barrier of lack of intrinsic motivation. Although we did not formally assess what feedback was most encouraging to participants, participants appeared to be more encouraged by the acknowledgment of improvement from their baseline rather than how close they were to their overall targets. Future studies should focus on establishing the optimal content and method of delivery of feedback and encouragement. For example, older participants or those with higher BMI may require alternate motivational strategies. It is also possible that patients were motivated in part by having access to a pedometer and seeing their step counts [23] or by being given the opportunity to participate in an intervention. However, some patients reported a lack of motivation even after gaining access to their pedometers. Other barriers expressed prior to the intervention, such as concerns about the safety of walking and about the ability to use the device, were not associated with achieving weekly goals and therefore should not be considered insurmountable obstacles to increasing walking.

Not surprisingly, safety concerns did limit achievement of overall targets set at the beginning of the intervention, as did environmental or weather-related barriers experienced during the intervention. Health-related barriers were also associated with lower odds of meeting the overall target. Dialysis patients are at significantly higher risk for hospitalization than the general population [30], and dialysis patients with impaired functional status are at even higher risk [6], which presents a difficult problem for any activity intervention in this population. Health-related barriers were associated with a smaller increase in steps from 0 to 12 weeks. However, despite these obstacles, the overall retention of participants in the intervention was above average for studies of this kind. Furthermore, there was no association of the presence of a health-related barrier with lower likelihood of achieving weekly goals, which may imply 'resetting' weekly goals for participants with health-related setbacks is an effective strategy to provide continued encouragement in a nontrial setting and a step in the right direction toward implementing this type of program more widely. However, the low rate of meeting overall goals in the setting of these barriers (and particularly the effect of medical issues on increase in steps), might argue for a longer, slower approach to increasing walking in patients with these types of barriers.

Our study has several limitations that should be acknowledged. Formal qualitative analysis involving audio recording of interviews and verbatim transcription may have provided more granularity into specific motivations and barriers as well as greater insight into individual experiences, which may have allowed better assessment of which aspects of counseling sessions participants were most responsive to. Themes were not developed by two independent reviewers and so we are unable to include an assessment of inter-rater reliability. Weekly counseling sessions lasted ∼10–15 min per session. Developing relationships with patients to properly motivate them and maintaining this frequency of contact would be labor-intensive on a larger scale. We acknowledge that relatively few women participated in our intervention. However, any difference in distribution of sex was the result of chance due to randomization and so does not necessarily reflect on the propensity of men versus women to participate in such interventions. Study participants were all selected from dialysis facilities in Northern California, which may limit generalizability of motivators and barriers to physical activity to the broader dialysis population, particularly for environmental or weather-related barriers.

For clinicians interested in increasing physical activity among their dialysis patients, a low-intensity intervention such as pedometer-guided walking may be more effective if performed after eliciting participants' individual motivations and barriers, and this aspect should be considered a key part of any activity intervention. Patients who express a desire to maintain or improve functional ability may be particularly motivated to

engage with such an intervention. Barriers such as lack of motivation to improve activity, initial difficulty with using the device and concerns about safety while walking can all be addressed and should not be seen as absolute contraindications to increasing walking. Health-related setbacks should be met with revision of activity targets and not with automatic cessation of efforts to increase activity.

SUPPLEMENTARY DATA

Supplementary data are available at ndt online.

FUNDING

A.S.'s work was supported by an American Kidney Fund Clinical Scientist in Nephrology Fellowship and a Ruth L. Kirschstein National Research Service Award (NRSA) Individual Postdoctoral Fellowship (F32 DK111154-02). ClinicalTrials.gov ID NCT02623348. Dr. Kittiskulnam received support from an International Society of Nephrology fellowship. K.L.J. was supported by a Midcareer Investigator Award in Patient-Oriented Research (K24-DK085153). None of the funders had a role in study design, data collection, analysis, reporting or the decision to submit for publication.

AUTHORS' CONTRIBUTIONS

Research idea and study design were proposed by A.S., P.K. and K.L.J. Data acquisition was done by A.S. and P.K. Statistical analysis and interpretation were done by A.S. Manuscript drafting and revision were done by A.S., C.D., R.S., J.C.L. and K.L.J. Supervision and mentorship were carried out by J.C.L., R.S. and K.L.J. Each author contributed important intellectual content during manuscript drafting or revision and accepts accountability for the overall work by ensuring that questions pertaining to the accuracy or integrity of any portion of the work are appropriately investigated and resolved.

CONFLICT OF INTEREST STATEMENT

None declared. The results presented in this article have not been published previously in whole or in part.

REFERENCES

1. Nelson ME, Rejeski WJ, Blair SN *et al.* Physical activity and public health in older adults: recommendation from the American College of Sports Medicine and the American Heart Association. *Circulation* 2007; 116: 1094–1105
2. Fried LP, Tangen CM, Walston J *et al.* Frailty in older adults: evidence for a phenotype. *J Gerontol Med Sci* 2001; 56A: M146–M156
3. Hayhurst WS, Ahmed A. Assessment of physical activity in patients with chronic kidney disease and renal replacement therapy. *Springerplus* 2015; 4: 536
4. Kittiskulnam P, Sheshadri A, Johansen KL. Consequences of CKD on functioning. *Semin Nephrol* 2016; 36: 305–318
5. Johansen KL, Chertow GM, Jin C *et al.* Significance of frailty among dialysis patients. *J Am Soc Nephrol* 2007; 18: 2960–2967
6. DeOreo PB. Hemodialysis patient-assessed functional health status predicts continued survival, hospitalization, and dialysis-attendance compliance. *Am J Kidney Dis* 1997; 30: 204–212
7. Johansen KL. Exercise in the end-stage renal disease population. *J Am Soc Nephrol* 2007; 18: 1845–1854
8. Allen K, Gappmaier E. Exercise habits and attitudes of patients undergoing hemodialysis. *Cardiopulmon Phys Ther J* 2001; 12: 11–16
9. Tentori F, Elder SJ, Thumma J *et al.* Physical exercise among participants in the Dialysis Outcomes and Practice Patterns Study (DOPPS): correlates and associated outcomes. *Nephrol Dial Transplant* 2010; 25: 3050–3062
10. Sheshadri A, Johansen KL. Prehabilitation for the frail patient approaching ESRD. *Semin Nephrol* 2017; 37: 159–172
11. Cheema BS, Singh MA. Exercise training in patients receiving maintenance hemodialysis: a systematic review of clinical trials. *Am J Nephrol* 2005; 25: 352–364
12. Storer TW, Casaburi R, Sawelson S *et al.* Endurance exercise training during haemodialysis improves strength, power, fatigability and physical performance in maintenance haemodialysis patients. *Nephrol Dial Transplant* 2005; 20: 1429–1437
13. Shalom R, Blumenthal JA, Sanders Williams R *et al.* Feasibility and benefits of exercise training in patients on maintenance dialysis. *Kidney Int* 1984; 25: 958–963
14. Arem H, Moore SC, Patel A *et al.* Leisure time physical activity and mortality: a detailed pooled analysis of the dose-response relationship. *JAMA Intern Med* 2015; 175: 959–967
15. Moorman D, Suri R, Hiremath S *et al.* Benefits and barriers to and desired outcomes with exercise in patients with ESKD. *Clin J Am Soc Nephrol* 2019; 14: 268–276
16. Delgado C, Johansen KL. Barriers to exercise participation among dialysis patients. *Nephrol Dial Transplant* 2012; 27: 1152–1157
17. Abdel-Kader K, Unruh ML, Weisbord SD. Symptom burden, depression, and quality of life in chronic and end-stage kidney disease. *Clin J Am Soc Nephrol* 2009; 4: 1057–1064
18. Zukiman W, Yaakup H, Zakaria NF *et al.* Symptom prevalence and the negative emotional states in end-stage renal disease patients with or without renal replacement therapy: a cross-sectional analysis. *J Palliat Med* 2017; 20: 1127–1134
19. Kontos PC, Miller KL, Brooks D *et al.* Factors influencing exercise participation by older adults requiring chronic hemodialysis: a qualitative study. *Int Urol Nephrol* 2007; 39: 1303–1311
20. Sheshadri A, Kittiskulnam P, Lazar AA *et al.* A walking intervention to increase weekly steps in dialysis patients: a pilot randomized controlled trial. *Am J Kidney Dis* 2019. doi: 10.1053/j.ajkd.2019.07.026
21. Tudor-Locke C, Washington TL, Hart TL. Expected values for steps/day in special populations. *Prev Med* 2009; 49: 3–11
22. Tudor-Locke C, Bassett DR. How many steps/day are enough? Preliminary pedometer indices for public health. *Sports Med* 2004; 34: 1–8
23. Nowicki M, Murlikiewicz K, Jagodzińska M. Pedometers as a means to increase spontaneous physical activity in chronic hemodialysis patients. *J Nephrol* 2010; 23: 297–305
24. Bravata DM, Smith-Spangler C, Sundaram V *et al.* Using pedometers to increase physical activity and health: a systematic review. *JAMA* 2007; 298: 2296–2304
25. Pope C, Zeibland S, Mays N. Qualitative research in health care: analysing qualitative data. *Br Med J* 2000; 320: 114–116
26. Goodman ED, Ballou MB. Perceived barriers and motivators to exercise in hemodialysis patients. *Nephrol Nurs J* 2004; 31: 23–29
27. van Adrichem EJ, van de Zande SC, Dekker R *et al.* Perceived barriers to and facilitators of physical activity in recipients of solid organ transplantation, a qualitative study. *PLoS One* 2016; 11: e0162725
28. Clarke AL, Young HM, Hull KL *et al.* Motivations and barriers to exercise in chronic kidney disease: a qualitative study. *Nephrol Dial Transplant* 2015; 30: 1885–1892
29. Johansen KL, Kaysen GA, Dalrymple LS *et al.* Association of physical activity with survival among ambulatory patients on dialysis: the comprehensive dialysis study. *Clin J Am Soc Nephrol* 2013; 8: 248–253
30. United States Renal Data System. *2018 USRDS Annual Data Report: Epidemiology of Kidney Disease in the United States.* Bethesda, MD: National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases

Received: 19.7.2019; Editorial decision: 17.1.2020